POPULATION BULLETIN

POPULATION REFERENCE BUREAU, INC.

VOLUME XIV MARCH 1958 NUMBER 1

World-Wide War on Malaria

Prelude to a Greater Challenge

Some 88 nations have mounted an all-out attack against an evasive enemy which has killed or incapacitated more people than all the battles of history.

This is the *Anopheles* mosquito. Some 50 species are known to transmit the scourge of malaria.

Only the female mosquitoes carry the malaria parasite from man to man. The males are harmless because they have no appetite for human blood.

Since the end of World War II, widespread use of DDT in the world's malaria-infested areas has nearly broken this lethal chain and sharply reduced the incidence of malaria and other major insect-borne diseases.

But now, after several years of effective DDT control, some species of *Anopheles* are developing resistance to the chemical. Multiplication of these DDT-resistant mosquitoes endangers the great gains made in the malaria battle in recent years.

So a race is on against time and genetic change in the mosquito. Science and technology must deal the final, fatal blow to the disease within the next few years, before the mutant strains of *Anopheles* replace the vulnerable strains almost exterminated by DDT. If this race is won, malaria can be eliminated. The obstacles in the way of success are very great.

This new, all-out fight against malaria is sponsored jointly by the World Health Organization, Pan American Sanitary Bureau and other international organizations. By aiding governments to fight the disease, the program aims to wipe malaria from the face of the earth in no more than 10 years.

Approximately 520 million dollars will be spent in the next 5 to 10 years, and of this the United States is asked to underwrite about 20 percent. Last December, the initial contribution of seven million dollars was turned over by Secretary of State John Foster Dulles, on behalf of the International Cooperation Administration, to the two agencies administering the program.[1]

It is not surprising that technical aid programs have become a forceful instrument of foreign policy, used by both the east and the west in wooing the "uncommitted" nations. When such programs attack malarial death and reduce the widespread debilitating effect of the disease, they have a compelling appeal. The cost is not too great and the results are spectacular.

But while solving one major

problem these programs may inadvertently accentuate poverty and malnutrition in some underdeveloped nations where living levels are already the lowest on earth. So the world faces an unprecedented challenge which must be met if poverty and misery are to be reduced.

When death rates fall rapidly, as they will under the impetus of the attack on malaria, and birth rates continue at their traditionally high levels, population growth inevitably soars. This rapid growth stifles capital formation in many underdeveloped countries. This endangers programs initiated to increase production and improve levels of living.

Since 1946, population growth has outrun production in many underdeveloped countries where modern public health measures have been initiated. Unfortunately, these programs have not lowered birth rates.

Two-thirds of the earth's people now live in underdeveloped areas where birth rates have remained high. With such a large population base, it follows that further death-rate reductions in these areas will again speed up already rapid rates of world population growth. An effective global attack on malaria will intensify this trend.

In the long run, unless birth rates are cut substantially in these areas, the blessings of malaria eradication cannot be fully realized.

Realistic and responsible leaders in many countries are beginning to recognize the problem as the unprecedented challenge of the future. They are aware that eradication of malaria will become the boon which is intended only if two other major changes can be initiated simultaneously. Production must be increased. Acceptable methods of controlling fertility must be found and made available.

None of these actions alone can lift the people of the underdeveloped nations from their age-old poverty. But if all three were taken collectively and simultaneously, population pressure should gradually decline and the present levels of living might rise.

THE MYSTERY OF MALARIA

Though the malaria parasite has run roughshod across the pages of history, the extent of the disease in ancient times can only be surmised. Descriptions of malaria's symptoms appear frequently in the Bible. It doubtless was prevalent in earliest times in Palestine, Assyria, Babylon, India, southern China and along the Nile River.

There is some historical evidence that malaria may have contributed to the fall of the Greek and the Roman Empires. An interesting example is found in the current official guide to museums and monuments of Italy.[2]

The Greek city, Poseidonia, named in honor of the god of the sea, was founded in the middle of the VIIth century B.C. on the banks of the river Sele. Now, the grandeur of the ruins, easily accessible from Salerno, are mute reminders of the prosperity and high level of culture developed by those ancient Greeks

who were conquered by the Lucanians, an Italic people, in 400 B.C., liberated in 332 B.C. by Alexander the Molossian, King of Epirus and nephew of the great Macedonian, and reconquered by the Lucanians again shortly after Alexander's death in 326 B.C.

Rome's power was rising, and in 273 B.C., a Latin colony called Paestum was founded on the historic site. The Romans built their grand edifices—the Baths, the portico of the Forum, the so-called Temple of Peace and the Amphitheatre. All are in ruins today.

The forests on Paestum's nearby mountains and hills and cereal grain production on her plains contributed mainly to the colony's great wealth. Over-cutting of the forests and overcultivation of the land upset the ecological balance and set off a cycle which ended in malaria. This enemy proved much more formidable than war:

> . . . The town continued to prosper until the time of the late Empire, thanks to her trade in the cereals and oil produced in the surrounding plain and mountains. Her population, instead, was decimated by malaria produced by the silting up of the river Salso [Sele] that ran by her south walls . . . and by the swamps developed by waters descending to the east of the town, from the mountains that had been deforested. Strabo (the Greek geographer who lived at the time of Augustus) himself wrote about how the banking up with sand of the mouth of the river Salso had rendered the climate of Paestum unhealthy. . . . In the IX century A.D., perhaps following incursions by the Saracens, the few remaining inhabitants took refuge on the slopes of the mountains . . . . . where the remains of walls and towers dating from that period are still visible. . . . In time the deserted city was hidden by forest and swamps, and even the memory of its location was lost. It was discovered only about the middle of the XVIII century, during the reign of Charles III of Bourbon, . . .[3]

The Romans had a goddess of malaria — Febris, "a hairless old hag with a prominent belly and swollen veins."[4] But beyond noting malaria's association with low, swampy areas and building temples to Febris, the Romans made little headway in fighting the disease. In fact, little progress was made for the next 2,000 years. Not until the end of the nineteenth century was the myth exploded that malaria (meaning "bad air" in Italian) was caused by breathing an evil miasma rising at night from low swampy lands.

In November 1880, a French army surgeon, Charles Louis Alphonse Laveran, definitely established that malaria is caused by a specific parasite called *Plasmodium* which invades the red blood cells. This discovery won Laveran a Nobel Prize in 1907.[5]

But the question which still remained was how the one-celled *Plasmodium* — of which there are four recognized species—got into the human blood stream. The idea that the mosquito was the vector in spreading malaria was accepted only gradually. The weight of opinion in scientific and medical circles still supported the age-old belief that the *Plasmodium* either was inhaled from bad air or was taken into the body as a result of drinking swamp water.

Finally, 17 years after the para-

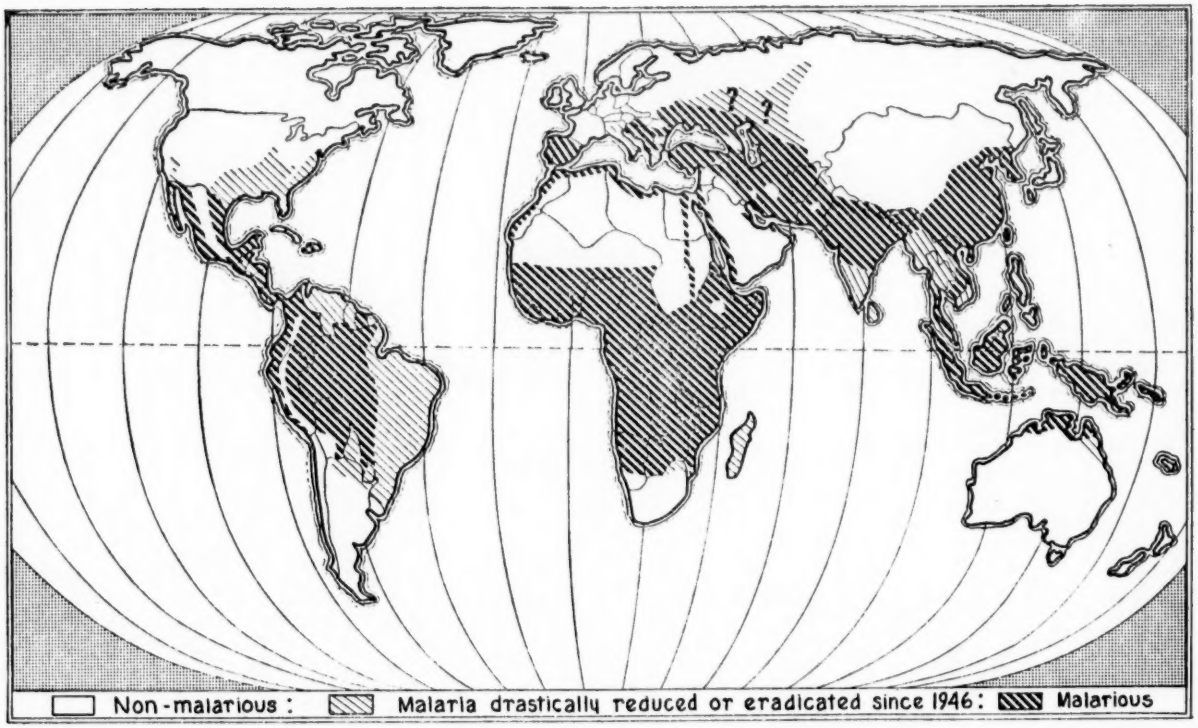

FIGURE 1: MALARIOUS AND NON-MALARIOUS AREAS OF THE WORLD. 1956

This map depicts the battle ground of the present fight against malaria. It will be noted that many of the dark shaded areas where malaria is still present are regions already under heavy population pressure. Attention is called to Table I, page 12. (Map modified from *Malaria Eradication*[6] and up-dated in cooperation with Dr. L. L. Williams.)

site had been identified, a British medical officer, Sir Ronald Ross, working in Calcutta, established positive proof that the mosquito was the intermediate host for the *Plasmodium* of malaria. Shortly thereafter, it was established that only the genus *Anopheles* transmitted the disease.

Now that the cause of malaria was identified, the second stage of the battle against the disease began. This, too, was a painfully slow process which took two directions: an attack on the disease; and an attack on the *Anopheles*.

THE ATTACK ON THE DISEASE

The attack on the disease itself has been mainly drug therapy. Until the seventeenth century, folk medicine was the only aid. It was generally accepted that malaria was a result of all sorts of heavenly disturbances: revolving planets, blazing comets and currents of starlight. Even in more recent times, superstition delayed the attack on the disease. Even today, many rural people throughout the world still wear small charms which they think will keep malaria away.

Quinine was the first important drug found to be effective against malaria. It was used extensively until World War II, when other important drugs were discovered. Quinine is produced from the bark of the Cinchona tree, of which there are some 40 species. These evergreen trees, native to the high, heavy rainfall area of South America, are located chiefly in Venezuela and Bolivia.

The first recorded use of Cinchona bark for malaria was by a Jesuit missionary in Peru in the year 1600. By 1650, the "Peruvian bark" was being used in Europe and in the American settlements. As the demand for quinine grew, the trees were recklessly destroyed.

By 1850, efforts were being made to procure Cinchona seeds from South America so that plantations and commercial production of the vital drug could be started in other parts of the world. The British and the Dutch succeeded. By 1872, there were over two and a half million trees growing in the Nilgiri Hills of Madras.

The Dutch developed hybrid trees and had 38 thousand acres producing 20 million pounds of bark annually by the outbreak of World War II. The Dutch in Java produced 90 percent of the world's supply of quinine and enjoyed a world monopoly on the drug. The world's largest quinine factories were located at Bandung.

Java's fall to the Japanese in March 1942 was a serious blow to the Allies whose forces were already fighting in two of the most malarious areas in the world, New Guinea and the Philippines.[7]

The search for new drugs began in earnest. The Germans had developed atabrine, and this eventually became the major anti-malaria drug throughout the war. Since then, continued research has provided several drugs even more effective than atabrine, namely chloroquine, amodiaquine and pyrimethamine.[8]

THE ATTACK ON *ANOPHELES*

For years, three major techniques were used to combat the mosquito: drainage to destroy the breeding grounds; oil and Paris green spread on the surface of the water to poison the mosquito larvae.

Scores of other techniques were tried. In the southern United States, a small fish of the genus *Gambusia* was used extensively as a natural enemy of the mosquito larvae. It was effective in small wells and cisterns but not in large lakes nor in extensive swampy areas.

Drainage was the most effective of the three methods but also the most expensive. It was widely used in the southern states during the depression years. In six and a half years, the relief administration engaged a daily average of 211,000 men who dug more than 60,000 miles of ditches to drain over 1,000,000 acres of breeding grounds. In one year alone, 1937, more than 3,100 miles of ditches were dug to remove the breeding water from more than 67,000 acres. Yet a year later, the United States was still reporting from two to four million cases of malaria.[9]

In 1940, Mussolini completed the drainage of Italy's famous Pontine Marshes which had been highly malarious for centuries. This project provided 200 thousand acres of additional farm land, enough to support 50 thousand people.[10]

As far back as 1793, it was noted that whale oil killed mosquitoes breeding in rain barrels and cisterns, but this control technique was not used until after Ross discovered that the mosquito was the carrier of malaria. In 1952, more than a million gallons of petroleum oil was used in the United States to control this insect.[11]

The third major method of eradication, the use of Paris green, was first demonstrated to be effective in 1921. It was extensively used until DDT became available after World War II. However, Paris green was effective on the mosquito's larvae but not on the adult.

MALARIA AND THE PANAMA CANAL

When the French undertook to build the Panama Canal in the 1890's, it was not yet known that the mosquito spread yellow fever and malaria. Eight years of struggle cost approximately 50 thousand lives and 260 million dollars. The records indicate that at any given time at least one-third of all French laborers and staff was in the hospital. A report issued at the time stated that "there were hardly enough trees on the Isthmus for crosses to mark the graves of the laborers."[12]

The United States took over the work of digging the Canal in 1904. Dr. William C. Gorgas, a major in the United States Army Medical Corps, was placed in charge of malaria control. Gorgas' successful battle against the disease and the mosquitoes—and the bureaucrats—stands out in history as one of the greatest medical achievements of all time. In the face of

almost insurmountable administrative difficulties, he all but eliminated malaria from the Isthmus and did eradicate yellow fever. In the building of the Panama Canal, Major Gorgas was an essential man.

In 1906, the malaria rate, based on men admitted to hospitals, was 821 per 1,000 workers. By 1913, Gorgas had cut the rate to 76. Based on the French experience, Gorgas kept an average of 12 thousand men a day out of the hospital during the years 1904-1914. It has been estimated that without effective malaria control, the total loss in American lives would have been increased by 70 thousand.

Major Gorgas' remarkable feat was accomplished without the use of either Paris green or DDT.[13] Swamps and stagnant pools were drained and those which could not be drained were oiled. Unnecessary accumulations of water around houses were eliminated.

ROCKEFELLER FOUNDATION AIDS BRAZIL AND EGYPT

Another striking example of effective pre-DDT malaria control took place in Brazil. In 1930, *Anopheles gambiae,* a notorious malaria carrier native to Africa, was discovered in the city of Natal. By 1931, it had spread 115 miles along the coast. By 1938, one of the worst malaria epidemics in the Americas was raging. Well over 100 thousand cases and 14 thousand deaths were reported in that region of Brazil between January 1 and July 1, 1938.

The situation became so serious that the Brazilian government set up a malaria service in 1938. Doctors Fred L. Soper and D. Bruce Wilson, both of the Rockefeller Foundation already in Brazil with the National Yellow Fever Service, undertook to bring to this problem the experienced and trained staff from this Service and directed the first all-out attack against the mosquito. Paris green was used on the breeding places and pyrethrum spray was used on the adult mosquitoes. The project was a complete success: not a single live larva nor adult *Anopheles gambiae* mosquito could be found in the country by 1942.

Early that year, Egypt was hit by a malaria epidemic along the Upper Nile so widespread and devastating that all agriculture and business activities stopped in many areas. Over 70 percent of the population was afflicted with the disease. *Anopheles gambiae* again proved to be the vector. Again the Rockefeller Foundation sent Doctors Soper and Wilson to lead the attack. By the middle of 1945, not a single *Anopheles gambiae* was to be found in Egypt.[14]

THE DDT ERA

The greatest boon to the war on malaria has been DDT (Dichlorodiphenyl-trichloroethane). Contrary to general belief, this wonder chemical is not new. It was first synthesized in Germany in 1874, but not until 1939 did Paul Müller discover its power to kill certain types of insects. When Dr. Müller was awarded a Nobel Prize in 1948

for this discovery, he was the second man so honored for work relating to malaria.

The development and use of DDT grew rapidly during and since World War II. In 1942, the Swiss used 150 tons effectively against many agricultural pests.

By 1944, the United States was producing 4,700 tons a year; by 1947, 24 thousand tons; and by 1957, 65 thousand tons.[15]

What is new about DDT that makes it the most effective weapon yet devised in the age-old battle against malaria? DDT has no greater killing power than many other insecticides, but it is unique in that it retains the ability to kill for many months after it has been applied. This is what makes it so effective against mosquitoes.

Furthermore, DDT is cheap to produce, easy to store, easy to transport and easy to apply. It can be carried in a concentrated form to any spot on the globe where it is to be used, then mixed with water or some other carrying agent and applied with the simplest equipment. Finally, DDT is harmless to humans and to most other higher forms of animal life when used properly.

DDT was first used as an effective residual spray against *Anopheles* mosquitoes by Dr. A. W. Lindquist at the United States Department of Entomology Station in Orlando, Florida.

DDT AND THE MOSQUITO

Between 1943 and 1945, Allied troops around the world had received essential malaria protection from DDT, and the military has learned much about its use. This increased the existing and already quite formidable knowledge about mosquitoes.

Entomologists already knew that all species of mosquitoes do not live in the same places nor have the same breeding and feeding habits. There are some 200 species of *Anopheles*. About 50 of these transmit malaria. But only 20 species are considered major vectors.

Each species of *Anopheles* has certain ecological differences which had to be understood before an effective DDT attack could be launched.

To further complicate matters, the same species of *Anopheles* acts differently in different parts of the world. A few feed only during the day, but most feed at night or during the twilight hours. Some prefer human blood and others that of domestic animals. Certain species have a preference for animals but will bite humans if no animals are available. Some species are very shy little pests which bite a person only when he is asleep or has been quiet for a long period. Other species are quite bold and are not deterred by bodily activity. In all species, only the female bites.

Many of these facts about *Anopheles* were known to scientists before the days of DDT, but more knowledge was needed. Further research into the habits of the 20 species which are major malaria vectors revealed that they are almost all of a shy disposition and usually attack a victim while he

asleep in a house. Like its victim, the *Anopheles* enjoys a siesta immediately after it has dined.

This latter, human-like characteristic is the key to malaria eradication. *Anopheles'* rest is usually taken on a wall in the house where it has fed, and this is a natural point of contact for the mosquito and DDT, spread as a residual, microscopic film on the walls. Even six months after spraying, any *Anopheles* lighting on sprayed walls is soon dead.

DDT AND POPULATION GROWTH

The power of DDT as an insecticide is not limited to the mosquito. The house fly and some other disease-carrying insects are also susceptible. So anti-malaria campaigns simultaneously fight several important insect-borne diseases. For this reason, it is entirely possible that in its total impact DDT is the most effective single weapon the death-fighters have ever had. The story of malaria is therefore symbolic of the development of a new era in the attack on mortality around the world.

The saga of DDT as an adjunct to public health campaigns began in 1945, when two members of the Institute of Tropical Agriculture in Trinidad spent a week end in British Guiana. The Health Officer reported that the extremely high infant mortality rate of 250 or more* was due largely to insect-borne diseases. They told him of DDT. Shortly thereafter, he was able to get enough to spray by airplane a 10-mile area, including the city of Georgetown. Results were instantaneous. By 1948, the infant mortality rate dropped to 67. As a result, that small area had one of the most rapid rates of population increase ever recorded.[16]

When the war ended, DDT soon became generally available and its use extended very rapidly. Ceylon is the classic example of the effectiveness of the chemical as a death-deferring tool because that country has rather complete and reliable vital statistics to document what happened.

When the anti-malaria campaign began in 1946, Ceylon's death rate was 20.2; the birth rate was 38.2; the rate of natural increase was 18.0. That year there were 12,578 deaths from malaria. For the period of 1945-47, life expectancy at birth was 45.8 years.

In 1947, the death rate fell 29 percent, to 14.3. There were only 4,557 deaths from malaria. The birth rate rose to 39.3. The rate of natural increase rose to 25.0.

By 1956, Ceylon's death rate had declined to 9.8. That means more than a 51 percent drop in the 10-year period since the anti-malaria campaign was initiated. There were only 144 deaths from malaria. During the decade, the birth rate declined only slightly, to 36.4. The rate of natural increase was 26.6, up 48 percent from 1946. Life expectancy at birth had increased to over 60 years.

*Infant mortality rates are in terms of deaths of infants under one year of age per 1,000 live births. Birth rates, death rates and rates of natural increase are in terms of 1,000 of the population per year.

As briefly stated above, these statistics do not reveal two important factors which should be noted. The 29 percent decline in the long-term trend of Ceylon's death rate in one year was without precedent in history. In contrast, it took Sweden and most other industrial countries of the west about half a century to achieve so great a decline prior to the wonder drug era.

In 1946, Celyon's population was growing at 1.8 percent a year. That rate had increased to about 2.7 percent by 1956. Should this increase persist, Ceylon's population will double every 26 years.[17]

Venezuela was one of the first countries to attempt total eradication of malaria with DDT. Between 1945 and 1952, all houses were sprayed twice each year at an annual per capita cost of about 58 cents. Now, malaria is an uncommon disease there.[18]

It has been reported that about 75 percent of all houses in malarious areas of Latin America are now being sprayed at least once a year, with similar results.[19]

The same success was achieved in Italy and Greece, where malaria had been prevalent for centuries. In 1945, Italy reported 412,000 cases, and approximately 1,000 deaths from the disease. By 1957, the disease had been eradicated.

Until 1945, Greece was one of the most highly malarious areas of the Mediterranean. At one time, it was estimated that one-third of the country's population suffered from this disease each year. In 1947, DDT residual spraying began in every single house in every single community within the malarious area. As a result, malarial deaths fell from 1,856 in 1942 to only 14 in 1950.[20]

By 1950, country after country was joining the battle against malaria, with the assistance of such organizations as the Rockefeller Foundation, the World Health Organization, the Pan American Sanitary Bureau, the International Cooperation Administration, etc.

GENETIC MUTATION THREATENS THE FIGHT

In 1951, word came from Greece that after six years of exposure to DDT, one species of *Anopheles* appeared to be developing a resistance to the chemical. This was confirmed by laboratory and field tests. Then similar disturbing news came from Lebanon, the United States, Java, Saudi Arabia and northern Nigeria.[21]

By 1954, it was clear that the resistance developed in those areas where DDT had been used for several years. What was happening was that those rare *Anopheles* which had an inherent (genetic) resistance to DDT survived to reproduce the next generation.

Among their progeny, the more resistant individuals again survived. This "survival of the fittest" rapidly led to a new strain of *Anopheles* capable of living in a DDT environment.

The emergence of DDT-proof strains in many countries brought a new urgency to the war against malaria. Unless man can deliver

a fatal blow quickly enough to break the malaria chain, the *Anopheles* mosquito threatens to multiply itself back into its role as public health enemy number one.

From Panama came another note of alarm. In addition to developing physiological resistance, at least one species of *Anopheles* appeared to have changed its behavior habits, thereby evading contact with residual spraying.[22]

Fortunately, resistance to DDT does not mean immunity to DDT. By increasing the concentration of the residual spray, it is still possible to kill resistant strains of the mosquito, but as the concentration of DDT increases it appears that the mosquito's resistance also increases. This eventually would lead to a total immunity.

Of the more than 50 species of *Anopheles* known to transmit malaria, seven now show some degree of resistance in certain parts of their geographical range.[23] Other species will undoubtedly develop resistance within the next few years since such resistance usually appears six to seven years after exposure to DDT. However, resistance after only 18 months of spraying was reported in one case.

DDT TO BREAK THE CHAIN REACTION

The implications are clear enough. Extermination of the *Anopheles* is impossible. But the *Plasmodium* can be eliminated while the mosquito population is reduced to a minimum for a period from four to six years.

DDT and its related insecticides —dieldrin, chlordane and B.H.C. (benzene hexachloride) — have made possible a new approach to malaria control. Instead of attempting to eliminate all the mosquitoes, this strategy will endeavor to check transmission of the disease. The United Nations' Report on the World Social Situation explains how this will be achieved:

> . . . The practice now aims at stopping the transmission of the disease during three or four consecutive years by intensive DDT-residual-spraying, and then discontinuing the spraying completely in order to prevent the development of resistant anopheles mosquitoes. The new approach is based on recognition of the fact that "Malaria eradication does not mean or require eradication of the anopheline species that carry the disease in a given area. It only means eradication of the malaria parasites."[24] Malaria, when it does not kill, is spontaneously self-curing. Inasmuch as infection lasts generally no longer than three or four years, at the most, except in certain rare forms, the effort is made to establish complete control of the mosquitoes for that period of time through intensive DDT-residual-spraying. If the life-and-infection cycle in the "parasite to mosquito to human being" circuit is thus interrupted and the human population ridden of malaria parasites, mosquitoes may well remain or reappear in the inhabited areas after residual-spraying is discontinued, but they will not be disease carriers, because they will find no parasite-infected human beings to bite. Thus, eradication of the disease has practically been achieved throughout, or in large areas of, British and French Guiana, Italy, the United States, Argentina, Ceylon, Thailand and Venezuela. For the success of this procedure, it is essential that complete malaria control be achieved during the three or four-year period during which previously infected human beings still carry the malaria parasites; this implies the

necessity of regularly spraying even remote villages, including those where malaria rates have been low. Moreover, the controlled areas should be as large as possible, so as to minimize the possibility of the reintroduction of malaria parasites through the movements of infected human beings or mosquitoes.

In the remaining parts of the world, malaria control or eradication work has been initiated, or the disease has already become insignificant as a public health problem.[25]

The cost of malaria eradication involves somewhat heavier initial expenditures than malaria control. However, after the initial period, expenditures are expected to drop rapidly. But there is no foreseeable end to malaria control programs. If DDT is relied on, control programs must eventually fight mosquito resistance with the older, less efficient, more expensive prewar techniques unless new and more potent insecticides can be developed. Few of the underdeveloped countries can afford the increased costs which the prewar practices would entail.

SOCIAL IMPLICATIONS OF MALARIA CONTROL

A humanitarian view almost universally held is that human beings should not be allowed to die if there is some known and practical way to enable them to live. That belief has inspired medical research throughout the ages. It has been

TABLE I: MALARIA ESTIMATES: WORLD SUMMARY[26]

Locality	Population (Mid-1954)	Population in Malarious Areas	Population Routinely Protected	Population Poorly or Not at All Protected
		(in thousands)		
North America	216,739	79,779	62,061	17,718
West Indies	17,537	8,491	5,266	3,225
South America	121,018	51,698	27,369	24,329
Totals, Americas	355,294	139,968	94,696	45,272
Northern and Northeastern Africa	73,347	35,308	14,536	20,772
Central and Western Africa	84,251	82,513	7,726	74,787
Southern Africa	32,843	21,445	6,893	14,552
Eastern Africa	20,375	17,862	780	17,082
Totals, Africa	210,816	157,128	29,935	127,193
Totals, Europe	404,829	41,991	34,666	7,325
Near East	57,257	37,908	20,257	17,651
Arabian Area	13,272	9,840	1,122	8,718
Middle Asia	533,239	373,097	125,142	247,955
Far Eastern Asia	849,582	258,629	31,598	227,031
Totals, Asia	1,453,350	679,474	178,119	501,355
Totals, Oceania	14,268	1,719	97	1,622
Totals, USSR	214,500	50,000	37,000	13,000
Totals, World	2,653,057	1,070,280	374,513	695,767

effectively implemented during the twentieth century. As a result, a baby's life expectancy at birth in the western world today is considerably greater than that of its parents; far greater than that of its grandparents.

Even in the economically underdeveloped countries, life expectancy is increasing—mainly as a result of fewer infant deaths. Death rates have been declining somewhat in most parts of the world. Since 1945, the rapid diffusion of many different technical skills around the world has accelerated the attack on mortality.

But these new techniques have had virtually no effect on birth rates which have remained at their traditionally high level in most of the underdeveloped countries. As a result, population has been growing at faster and faster rates. Growth has been most rapid in precisely those regions where per capita income is lowest and economic growth most retarded.

It cannot be too strongly emphasized that the acceleration in world population growth during the last decade is due to falling death rates rather than to rising birth rates. Thus, elimination of chronic and widespread malaria in many countries — and reduction of other insect-borne diseases in the wake of malaria campaigns — is contributing materially to the acceleration in world population growth.

If malaria is completely eradicated in the crowded, underdeveloped countries within the next five years, there will be still another increase in the rate of population growth.

Dr. Frank Notestein, Director of the Office of Population Research at Princeton University, has stated:

> Sustained population growth, even at a relatively low rate, is not possible for any period of time significant in the history of the human race. In principle, there must come a time at which low death rates could not be maintained without comparable low birth rates. This is an inexorable fact of nature . . . . death rates must rise or birth rates must fall.[27]

"BIRTH RATES MUST FALL" —BUT HOW?

The total expenditure by nations throughout the world today on medical care, public and private, is equivalent to at least 30 *billion* dollars per year. In 1955, the outlay for research in this country alone for control of only one major killer, cancer, amounted to 45.3 million dollars. Another 8 million was spent in cancer education.

The budget for research in the physiology of reproduction and the development and testing of new contraceptive methods does not approach one *million* dollars. Obviously, there is an imbalance of emphasis here.

Dr. Notestein's warning that "death rates must rise or birth rates must fall" poses a major challenge of this century. But before this challenge can be met certain comforting myths must be cleared away, among them: that a balance in population will come automatically; that technology can provide food and goods for any number of people; that industrialization and urbanization will quickly reduce birth rates through some undefined

magic; and now, even that outer space may absorb the world's excess population.

It is true that in most of the countries of the west, death rates declined slowly at the same time industrialization was slowly developing. This, and other factors, tended to reduce birth rates. But it should be emphasized that the demographic transition to low death rates and low birth rates in the west took over a century, during which time *population more than tripled.*

It is questionable that the same pattern of industrialization, with a shift from an agrarian to an urban culture, could be achieved in the underdeveloped countries now caught in the population squeeze. The capital and resource needs for such development are not available in sufficient scope in those countries. The United Nations' recent publication, "Report on the World Social Situation," clearly defines how rapid population growth retards economic development in underdeveloped areas.

As detailed in the preceding pages, the eradication of malaria now becomes a possibility because of the brilliant and dedicated research of physicians, chemists, biologists and sanitarians in many lands. The accumulated knowledge has been put to use by administrators of unusual competence.

The malaria eradication program is a symbol of the ever-growing efficiency of public health techniques. The speed with which it will influence death rates brings into focus a vitally important factor. This is *time.*

Will action to curb rapid population growth be taken in time?

A comprehensive attack on high birth rates, equally as intensive as that on death rates, could hold population growth within reasonable limits. Such a bold, hard-hitting attack should include research, education and implementation.

Of necessity, education and implementation should be geared to the mores and cultures of the various countries involved. Technical assistance for this objective from other countries may have to come from voluntary, non-government agencies for a long time.

In his State of the Union address, President Eisenhower urged the Soviet Government to join with the rest of the world in the fight against malaria. The time is overdue for a world leader of outstanding stature to enlist the forces of science and the humanitarian spirit of the malaria-fighters in an effort to solve the problem of fertility.

The moral imperative to keep reproduction in balance with the resources of the family and the nation is universally recognized. Means to do this, in terms of the needs and the scruples of some peoples, are still lacking. To solve this surpassing problem should cost only a fraction of what is being spent in cancer research. But until the leadership emerges, until the imagination and the conscience of mankind are enlisted, the job will not be done, and the future will remain in jeopardy.

—Robert C. Cook, *Editor*

SOURCES

In the preparation of this *Bulletin* the following sources were consulted. The reader is referred to them for additional information. Specific text references are given below.

1. Boyd, M. F. (Ed.) Human Malaria. Washington, D. C., American Association for the Advancement of Science, 1941.
2. Ceylon Department of Census and Statistics, "Statistical Abstracts of Ceylon." Various issues, Colombo, 1945-56.
3. Cook, Robert C. Human Fertility: The Modern Dilemma. New York, William Sloan Associates, 1951.
4. International Development Advisory Board. Report and Recommendations on Malaria Eradication. Washington, D. C., I.D.A.B., 1956.
5. Ministero Della Pubblica Istruzione. Paestum. Rome, Instituto Poligrafico Dello Stato, 1955.
6. Pan American Sanitary Bureau. News Release ROA/PR-025. Washington, D. C., December 6, 1957.
7. Russell, Paul F.
   A. Man's Mastery of Malaria. New York, Oxford Press, 1955.
   B. "World-Wide Malaria Distribution, Prevalence and Control." *American Journal of Tropical Medicine and Hygiene.* Vol. 5, No. 6, 1956.
8. United Nations.
   A. Department of Public Information. Press Feature 197-G/160857. New York, 1957.
   B. Bureau of Social Affairs. Report on the World Social Situation. New York, 1957.
9. World Health Organization.
   A. Bulletin of the World Health Organization, Vol. 15. Geneva, 1956.
   B. Experts Committee on Malaria, 5th Report. Geneva, W.H.O., 1954.

TEXT REFERENCES

1. Ref. 6; *2.* Ref. 5, p. 6; *3.* Ref. 5, p. 6; *4.* Ref. 7A, p. 9; *5.* Ref. 7A, pp. 31-32; *6.* Ref. 4, p. 23; *7.* Ref. 7A, pp. 90-196; *8.* Ref. 7A, p. 135; *9.* Ref. 1, p. 148; *10.* Ref. 7A, pp. 129-138; *11.* Ref. 7A, p. 137; *12.* Ref. 7A, pp. 130-141; *13.* Ref. 7A, pp. 143-146; *14.* Ref. 7A, pp. 237-240; *15.* Ref. 7A, p. 158; *16.* Ref. 3, p. 65; *17.* Ref. 2; *18.* Ref. 7A, p. 162; *19.* Ref. 7A, p. 163; *20.* Ref. 8A; *21.* Ref. 9A, p. 403; *22.* Ref. 9B, p. 11; *23.* Ref. 4, p. V; *24.* Ref. 8B, p. 32 ftn. 18; *25.* Ref. 8B, p. 32; *26.* Ref. 7B, p. 939; *27.* Ref. 7A, p. 248.

(This *Bulletin* is based on a research report prepared by Hugh C. Davis of the staff of the Population Reference Bureau, in cooperation with several distinguished malariologists, whose advice and suggestions were invaluable. The text was written by Annabelle Desmond in cooperation with several distinguished malariologists, to whom we are indebted for advice and suggestions. *R.C.C.*)

PRB SUMMER WORKSHOP

Six graduate students from the fields of demography, sociology, conservation, economics or geography will be chosen to attend the Population Reference Bureau's sixth annual Summer Workshop to be held in Washington, D. C., June 16-July 25, 1958.

Participants will receive a grant of $300 for this six-week period. Applications should be submitted on or before April 2, 1958, to Mr. Robert C. Cook, Director, Population Reference Bureau, 1507 M Street, N.W., Washington 5, D.C. Each application should explain how the student's major subject is related to the population problem and should be accompanied by two supporting letters from professors, instructors and/or faculty advisors.

POPULATION BULLETIN is published eight times a year by the Population Reference Bureau to provide population facts and interpretation of those facts in relation to world problems and problem areas. It is not a government publication. Annual subscription $3; single issues 50 cents each. Editor, Robert C. Cook; Writer, Annabelle Desmond; Business Manager, June del Solar; Circulation Manager, Frances T. Smith.

The **POPULATION REFERENCE BUREAU INC.,** founded in 1929, is a nonprofit, scientific, educational organization for the purpose of gathering, coordinating, interpreting and distributing population data. Sponsored by a group of biologists, sociologists and economists, it is financed by members, subscribers, individual contributions and foundation grants. Associate membership is $5 annually; membership for teachers, $3.

RECENT ISSUES: World Population Summary; The American Melting Pot: 1850-1950; Space: A Finite Factor; World Migration, 1946-1955; The Aesthetics of Population; Baby Boom Decade: 1946-1955; Decade of Declining Death Rates; Population vs Resources; Red China's Achilles Heel; Children in Spite of Ourselves—France Struggles with a Dilemma; College Study Reports—1954, 1955, 1956; Australia—Uncrowded Land Down Under; Egypt's Population Explodes; The American Farmer at Mid Century; French North Africa—A Demographic Maelstrom; Catholic Institute Seeks Solution to Population Pressures in Underdeveloped Areas; Life Grows Longer; Population in the United Nations; Born to Live—But How Long?; Hidden Hunger at "The Summit"; Problems of an Aging Population; Puerto Rico's New Look; Asian Population Roundup.

OFFICERS AND TRUSTEES

C. C. LITTLE, *President*
PASCAL K. WHELPTON, *Vice President*
MRS. GUY IRVING BURCH, *Secretary*
DONALD O'CONNOR, *Treasurer*
ROBERT C. COOK, *Director*
SAMUEL W. ANDERSON
KINGSLEY DAVIS
HAROLD F. DORN
FRANK H. HANKINS
RUFUS E. MILES, JR.
HUGH MOORE
KARL SAX
JOSEPH J. SPENGLER

POPULATION REFERENCE BUREAU, INC.
1507 M STREET, N. W.
WASHINGTON 5, D. C.

If addressee has moved, please notify sender on Form 3547.